written for students on the continent, where the method of malting differs somewhat from ours. The printing, paper, and binding of the book are particularly good.

A. J. B.

Curiosities of Light and Sight. By Shelford Bidwell, M.A., LL.B., F.R.S. Pp. xii + 226. (London: Swan Sonnenschein and Co., Ltd., 1899.)

MANY readers will be glad to possess this collection of essays, in which Mr. Shelford Bidwell describes some of the experiments which the scientific world owes to his ingenuity. The five chapters in the volume are based upon notes of lectures delivered to various audiences; and their subjects are: light and the eye, colour and its perception, some optical defects of the eye, some optical delusions, and curiosities of vision. Each subject is presented with freshness of style, and elucidated by many simple and convincing experiments. To the popular lecturer on science, who desires to know how to produce curious and instructive optical effects, the volume will be very acceptable, and every physical experimentalist may confidently turn to it for inspiration. But though the curiosities of colour phenomena, and of sight generally, are chiefly described in the book, many questions of deep interest to students of both physical and physiological optics are discussed, so that the volume appeals to scientific as well as popular readers.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Curious Salamander.

THE artificial propagation of food fishes is an important part of the work of the United States Fish Commission, and for this purpose it has a number of hatcheries or "stations" scattered throughout the Union. At each of these stations especial attention is given to the rearing of the fishes best adapted to the region in which that particular station is placed, as it would be useless to breed salmon or trout for the warm, sluggish streams of the South, or to put bass and carp into the cold, swift rivers of New England or of Michigan. The sea stations are devoted to the study of marine zoology, and the propagation of shad, mackerel, cod, lobsters and similar organisms that cannot be bred in fresh water; while hatcheries have been put on the banks of several lakes at which whitefish, land-locked salmon, lake trout and the like are reared.

A few years ago a station was established near the town of San Marcos, Texas, for the culture of black bass and "crappies." A prime essential for fish hatching is a copious supply of water, and the supply should be as uniform in amount, temperature and composition as it is possible to obtain. If there be much sediment in the water, it will be deposited on the eggs and suffocate them; and sudden variations in temperature may also be fatal. As the rainfall in western Texas is untrustworthy, the Commission determined to bore an artesian well to supply the water for its new station.

The well was bored successfully and a flow of twelve-hundred gallons per minute obtained from a depth of 188 feet. There are several such wells in this region that give this amount or more, but soon after the San Marcos well was opened a number of living animals began coming up with the water. So far, four kinds of Crustacea and a salamander have been seen, and of these quite a number have been obtained. The Crustacea are new to science and were described by Dr. James E. Benedict, of the Smithsonian Institution. They are white and perfectly blind. Most of the shrimps and crab-like animals have eyes set on the extremities of stalks that project above the surface. The shrimps from this well have the stalks, but the eyes have disappeared.

The most remarkable creature that has come from the well is the blind salamander, the *Typhlomolge Rathbuni*. The name

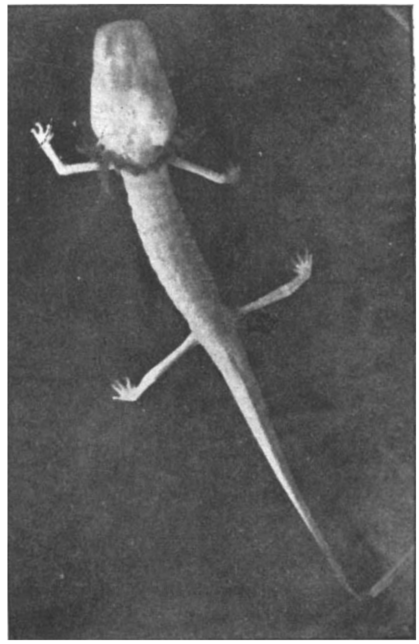

FIG. 1.—*Typhlomolge Rathbuni*, seen from above. (Photographed by W. P. Hay.)

is compounded from the Greek *typhlos*, blind, and *molge*, a kind of salamander; while the second term was given in honour of Mr. Richard Rathbun, the Assistant Secretary of the Smithsonian Institution, and for many years the Chief of the Division

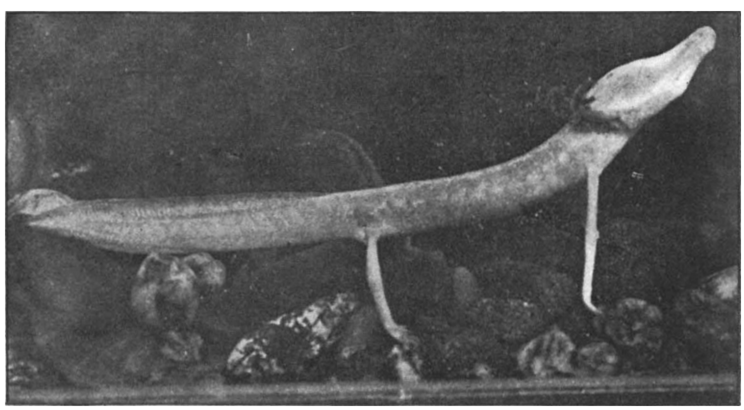

FIG. 2.—*Typhlomolge Rathbuni*, ¾ life. (Photographed by W. P. Hay.)

of Scientific Inquiry of the Fish Commission. This animal is a new species and a new genus. It was described by Dr. L. Stejneger, of the Smithsonian Institution. The *Typhlomolge* is from three to four and a half inches in length. It has a large head, protruding forward into a flattened snout that bears the mouth. The eyes are completely covered by the skin, and are visible from the outside only as two black specks. Just behind the head are the gills. These are external and stand out in festoons about the neck, instead of being covered by a lid as in fishes. The skin is a dingy white, and the sharp contrast between

the colourless skin and the vivid scarlet of the exposed gills makes the appearance of this subterranean visitor striking in the extreme. It has four long, slender legs, that are gruesomely human in appearance, and are supplied with feet that are startlingly hand-like. The fore feet bear four fingers or toes and the rear ones have five, and though the legs are extremely slender, they possess a considerable amount of strength. Behind, the body terminates in a flattened tail that bears a fin like that of an eel.

In April 1899, two living specimens of this strange being were shipped by mail from San Marcos to the head office of the Fish Commission in Washington. They bore the journey of nearly 1800 miles, and reached their destination in good condition. They excited great interest, and for some time after their arrival a wondering group of spectators crowded about the aquarium into which they were put. These living specimens corrected several errors that had been made from observations of the dead bodies only. The legs are used for locomotion, and the animals creep along the bottom with a peculiar movement, swinging the legs in irregular circles at each step. They climb easily over the rocks piled in the aquarium, and hide in the crevices between them. All efforts to induce them to eat have been futile, as has also been the case with blind cave fish in captivity and they are either capable of long fasts or live on infusoria in the water.

From whence do these strange creatures come? The well is sunk in limestone, and that renders it likely that there may be some great cavern or subterranean lake communicating with it, but the rock through which the hole is bored is solid, except for a single channel two feet in diameter. The fact that the water rises nearly two hundred feet shows it to be under great pressure, and altogether this well affords material for study to geologists as well as zoologists.

Washington, D.C. CHARLES MINOR BLACKFORD.

Palæolithic Implement of Hertfordshire Conglomerate.

THE rudely-made Palæolithic implement, illustrated to half the actual size in the accompanying engraving, is probably unique in the highly intractable material from which it is made. It was found by me in May last with Palæolithic implements of flint in the Valley of the Ver, Markyate Street, near Dunstable: its weight is 1 lb. $6\frac{1}{4}$ oz.—1677 in my collection. Although rude, there is no doubt whatever as to its true nature; there is a large bulb of percussion on the plain side, as seen in the edge

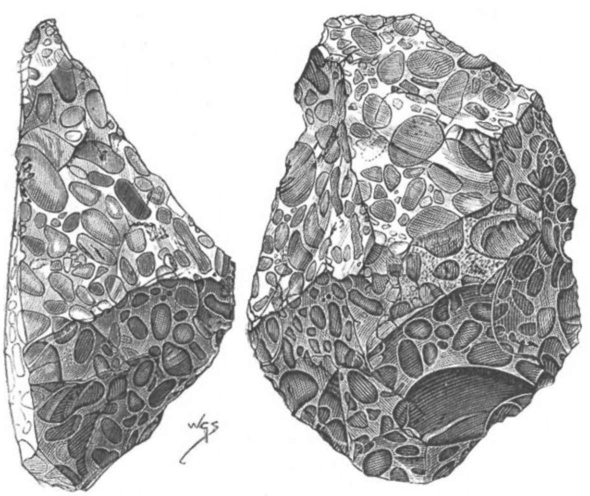

FIG. 1.—Palæolithic implement of Hertfordshire Conglomerate. One-half actual size.

view, and the hump-backed front is chipped to a rough cutting edge all round, each facet going right through the embedded pebbles. Its condition is totally different from a newly-broken block of Conglomerate, and indeed of Conglomerate broken in Roman times by quern-makers. It is faintly ochreous from being long embedded in clay, and sub-lustrous. Newly-broken Conglomerate is in colour a lustreless cold grey. The peculiar nature of the material would not admit of finer work: I have tried hard to flake Conglomerate without the slightest success; it breaks only after the heaviest blows, and then in the most erratic manner, the embedded pebbles often flying from the matrix. Sir John Evans has seen this example, and agrees with my conclusions as above expressed; he also informs me that several years ago he found what appears to be the point of a lanceolate implement of the same material and of Palæolithic character on the surface of a field near Leverstock Green.

Dunstable. WORTHINGTON G. SMITH.

On the Calculation of Differential Coefficients from Tables Involving Differences; with an Interpolation-Formula.

(1) IN NATURE for July 20 (p. 271) Prof. Everett has given formulæ for calculating first and second differential coefficients in terms of differences. The formulæ can be more simply expressed in terms of "central differences." Let the values of a function u_x be given for $x = \ldots, -2, -1, 0, 1, 2, \ldots$; then, with the usual notation,

$$\Delta u_0 = u_1 - u_0$$
$$\Delta^2 u_0 = \Delta u_1 - \Delta u_0 = u_2 - 2u_1 + u_0,$$
&c.

Now write

$$\tfrac{1}{2}(\Delta u_0 + \Delta u_{-1}) = a_0$$
$$\Delta^2 u_{-1} = b_0$$
$$\tfrac{1}{2}(\Delta^3 u_{-1} + \Delta^3 u_{-2}) = c_0$$
$$\Delta^4 u_{-2} = d_0$$
&c.

Then $a_0, b_0, c_0, d_0, \ldots$ are the "central differences" of u_0. Take, for instance, the following table:—

y	e^y	Δ			
4·7	109·947	11563	1217	126	17
4·8	121·510	12780	1343	143	12
4·9	134·290	14123	1486	155	19
5·0	148·413	15609	1641	174	15
5·1	164·022	17250	1815	189	24
5·2	181·272	19065	2004	213	18
5·3	200·337	21069	2217	231	28
5·4	221·406	23286	2448	259	
5·5	244·692	25734	2707		
5·6	270·426	28441			
5·7	298·867				

Writing $y = 5{\cdot}2 + {\cdot}1x$, and $u_x = 10^3 e^y$, so as to get rid of decimals, we have the following values corresponding to $y = 5{\cdot}2$ $(x = 0)$:—

u_0	a_0	b_0	c_0	d_0	e_0
181272	$18157\frac{1}{2}$	1815	$181\frac{1}{2}$	15	$2\frac{1}{2}$

With this notation, the value of u_x for values of x between $-\frac{1}{2}$ and $+\frac{1}{2}$ is given by

$$u_x = u_0 + xa_0 + \frac{x^2}{2!}b_0 + \frac{x(x^2-1)}{3!}c_0 + \frac{x^2(x^2-1)}{4!}d_0 + \frac{x(x^2-1)(x^2-4)}{5!}e_0 + \ldots \quad \text{(i.)}$$

This is a well-known formula. Differentiating with regard to x, and putting $x = 0$, we have (writing u for u_x)

$$\left(\frac{du}{dx}\right)_0 = a_0 - \tfrac{1}{6}c_0 + \tfrac{1}{30}e_0 - \tfrac{1}{140}g_0 + \ldots \quad \text{(ii.)}$$

Similarly, differentiating twice, and putting $x = 0$,

$$\left(\frac{d^2u}{dx^2}\right)_0 = b_0 - \tfrac{1}{12}d_0 + \tfrac{1}{90}f_0 - \tfrac{1}{560}h_0 + \ldots \quad \text{(iii.)}$$

Prof. Everett's formula for the "increase-rate" when fifth differences are negligible is obtained by taking the first two terms of (ii.).

(2) The advantage of these formulæ, as Prof. Everett points out, is their greater accuracy. The ordinary formula

$$\Delta - \tfrac{1}{2}\Delta^2 + \tfrac{1}{3}\Delta^3 - \tfrac{1}{4}\Delta^4 + \tfrac{1}{5}\Delta^5,$$

in the above example, would give for $y = 5{\cdot}2$

$$\frac{du}{dx} = 18131\tfrac{1}{2},$$

while, if the differences were taken backwards, we should get

$$\frac{du}{dx} = 18124\tfrac{1}{5}.$$